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Hybrid Two Wheeler [HYBYK]

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Abstract--- *Fuel consumption is one of the most important aspect which has to be noted before selecting any vehicle. Reduced usage of fuel with high efficiency is a characteristic of good vehicle. With the increase in demand for fossil fuels, the need for a fuel efficient two wheeler has increased to a greater extend. Due to aspects such as cost and reliability, alternate fuels cannot replace fossil fuels completely. These efforts are mainly towards achieving a fuel efficient two wheeler, 'HYBYK' which uses both IC engine and an Electric drive. In a two wheeler, while traveling a short distance fuel consumption to power output ratio is comparatively less. Whereas an electric bike cannot travel longer distance but can cover short distance effectively. HYBYK combines these two properties and add as an advantage. Since HYBYK has both engine and an electric drive short distance can be covered with the help of an electric drive and longer distance with high fuel to power output ratio. Also the system gets considerably charged while running. If fuel gets empty electric drive is there to help in hand. Besides there is a static solar power module which can be used to charge the battery. Thus charging the battery becomes almost pollution free. In a country like India where millions of people flock in traffic and waste fuel, HYBYK would serve better. Thus with reasons such as reduced fuel consumption, less polluting, economic, HYBYK would be a promising technology to Global Green scenario.*

Keywords--- *Fuel Consumption, Less Polluting, Economic, HYBYK.*

I. INTRODUCTION

Internal combustion engines are relatively inefficient at converting the on-board fuel energy to propulsion as most of the energy is wasted as heat. On the other hand, electric motors are more efficient in converting the stored energy in driving a vehicle, and electric drive vehicles do not consume power while at rest or coasting. Some of the energy loss in braking is captured and reused by regenerative braking. With the help of regenerative braking around one fifth of the energy loss can be regenerated. Typically petrol engines effectively use only 15% of its fuel content to move the vehicle. Whereas an electric drive vehicle has an on-board efficiency of about 80%. But due to reasons such as cost, inability to reach higher speeds electric drive vehicles failed to capture markets. To its contrast petrol vehicle can cover longer distances with higher speed but it cannot cover shorter distance with slow speed (say in traffic) in much fuel efficient way. Fuel efficient, less polluting, cost effective two wheeler could serve as a better means of transport in densely populated country like India. In recent times hybrid technology is gaining its importance in the field of automobile.

HYBYK also uses the basic principles of a hybrid vehicle. These fuel efficient bikes are a boon to be used in traffic prone cities. To satisfy the needs of charging the battery there is a dynamo which is attached to charge the battery while running itself. Static SOLAR power module which can also be used to charge the battery.

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Thus charging the battery becomes almost pollution free and free of cost. These efforts are to make a two wheeler which could run on both petrol as well as electric power, compiling the advantages of a petrol engine and an electric drive. The mechanism of running, components required, advantages, efficiency, pollution rate, cost are discussed in the following paragraphs.

II. THEORY OF HYBRID VEHICLE

2.1. Parallel Hybrids

In parallel hybrids, the internal combustion engine and the electric motor are connected to mechanical transmission and can transmit power simultaneously to drive the wheel. At present the commercialized parallel hybrids uses a single small electric motor and a small battery pack. Parallel hybrids are also capable of regenerative braking and also the internal combustion engine is capable of supplemental charging of the battery. Parallel hybrids are more efficient than the non-hybrid vehicles especially during the urban stop-and-go conditions and short distance applications where electric motor is permitted to contribute.

2.2. Plug-in Hybrid Vehicle

A Plug-in hybrid electric vehicle (PHEV), also called as Plug-in hybrid, is a hybrid electric vehicle with rechargeable batteries that can be restored to full charge just by connecting to an external power source. A Plug-in hybrid electric vehicle shares the characteristics of both conventional hybrid electric vehicle having an electric motor and an internal combustion engine; and of an all-electric vehicle, also having a plug to connect to an electric grid. HYBYK is a system which uses both the principles of Parallel hybrids and Plug-in hybrid electric vehicle

III. SPECIFICATIONS

3.1. Technical Specifications of HYBYK

Engine: 4 stroke, single cylinder

Motor power: 1100 W

Eng. Displacement:100 cc

Motor Torque: 33 N-m @ 150 rpm

Engine net Power: 5.63 kW @ 7500 rpm

Engine net Torque: 7.85 N-m @ 5000rpm

Motor max. Speed: 40-50 KMPH

Engine Idling speed: 1400 rpm

VehicleMax.Speed
(HighSpeedmode): 85km/hr

Front Brake: Mech. Expanding shoe

Fuel tank capacity: 8.0 lit

Battery capacity: 48V, 33AH

Charging time: 8 hrs

Battery type: Sealed maintenance free

Power for charging: 220V

Tyre pressure: 30 psi

Carrying capacity: 2 adults

Electrical system: 12V

Head lamp: 12 V, 35 W

Turn signal indicator: 1.7 W

Side indicator lamp: 12 V, 10 W

Note: All the values given above are to be tested; all the figures are expected to be attained.

IV. COMPONENTS

4.1. Electrical Components

4.1.1 Electric Motor

In olden times series wound DC motors, a form of brushed DC electric motors were used. More recent electric vehicles have made use of a variety of AC motor types, as these are easy to make and have no brushes to wear out. These are usually induction motors or brushless AC electric motors which use permanent magnets. There are several variations in the permanent magnet motors which offer sampler drive schemes and low cost.

4.1.2 Motor Controller

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means of starting or stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, protecting against overload and faults.

4.1.3 Speed Control Circuits

There is a special circuit system which is wired up in HYBYK to control the speed of motor just by raising or lowering the accelerator. The circuit gives a variable speed option to the motor drive. An interesting thing that to be noted in HYBYK is that it uses the same accelerator to control the speeds of both electric drive and engine.

4.1.4 Battery

HYBYK uses a Lithium-ion battery to power up the electric drive. While most of the electric vehicles are choosing Lithium-ion battery a variety of other alternative batteries can also be used. Lithium based batteries are chosen for the following reasons:

1. High power
2. Energy density
3. Durable

4.1.4.1 Lithiumion Battery

Lithium-ion batteries dominate the most recent group of electric vehicles in development. It uses a lithium-cobalt oxide cathode and graphite anode. It has a good Energy density and power density ratio.

It has about 80 to 90% of charge /discharge efficiency. More other lithium ion battery variants which are used in recent electric vehicles has a chemistry that sacrifices energy density to provide extreme power density, fire resistance, environmental friendliness, very rapid charges and very long life spans.

Other battery technologies include lead acid battery, NiCd, Nickel metal hydride etc.

4.1.5 Recharging

4.1.5.1 Regenerative Braking

Regenerative braking is a technique by which the power lost at the time of braking is regenerated and can be used further. Hence for recharging the battery while driving the vehicle in urban start-and-stop conditions where brakes are applied often the regenerative braking system can be used in a much effective way. Thus by using the regenerative circuit system we can achieve the goal of recharging while driving.

4.1.5.2 Dynamo

A dynamo is a device which is used to generate electricity with the help of a rotating mechanical member. HYBYK also uses one such dynamo to generate electricity while driving. The energy which is lost in mechanical transmission is greatly recaptured a selectric current by dynamo.

4.1.5.3 Plug-in Recharge

Another widely used option for recharging is Plug-in recharge type. HYBYK has a plug which can be connected to an external power source to resume the full power of the battery. It is stated all around the globe that electric vehicle also uses electricity which is got from a non-renewable energy source which is found polluting almost at every point of time. To overcome the above stated disadvantage HYBYK creates a new concept for Plug-in recharging. HYBYK can be provided with a Static SOLAR power module which is stationary and domesticated. By using the static solar power module HYBYK becomes almost pollution free and free of cost for recharging the battery.

4.1.5.4 Motor Generating

Motor generating is another option for recharge while driving. This method of generating electricity is in developmental stage. This method gives the option that battery can be recharged with the help of motor itself. In future this technology would become a great boon to electric vehicle. The line diagram for electrical transmission system is given below.

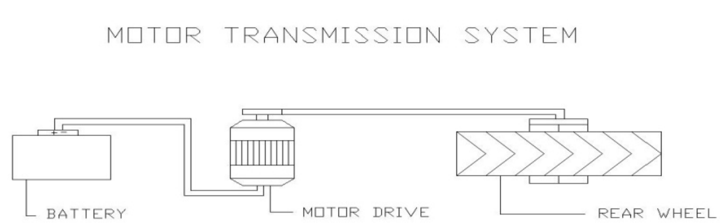

Fig 4.1: Showing the Line Diagram for Electrical Transmission System of HYBYK

4.2. Mechanical Components

4.2.1 Petrol engine

HYBYK is provided with a 4 stroke petrol engine with a single cylinder. The engine displacement of HYBYK is about 100cc. The bore×stroke dimensions of HYBYK are 47mm × 54.4mm. The lubrication for the petrol engine used here is wet sump forced type. This engine transmits a maximum power of 5.63 KW @ 7500 rpm.

4.2.2 Fuel Tank

HYBYK has a high capacity fuel tank. The reason behind providing a high capacity fuel tank is that it becomes hardly rare to run out of petrol. Greater efforts are made to reuse the size and weight of the fuel tank to increase the load carrying capacity of electric motor. Capacity of fuel tank is as follows:

Full: 8.0 lit

Reserve: 2.3 lit

4.2.3 Gearing

To attain variable speed in electric drive application a gear assembly is very much essential. Usually an electric vehicle uses two types of gears for selecting the gear ratios; they are derailleur gears and hub gears. The derailleur type uses sprocket gears whereas hub gears uses epicyclic gears. HYBYK also has one such sprocket gear assembly to multiply the speed ratio of electric motor. Though the speed of motor is less it can be modified to higher speed by using a gear assembly.

V. POSITION OF COMPONENTS

5.1 Position of Engine

The 4-stroke single cylinder petrol engine is placed underneath the fuel tank as it is present in all types of two wheeler at present. Reasons such as easy transport of fuel to engine, safety of engine, reduced losses due to transmission govern the position of engine.

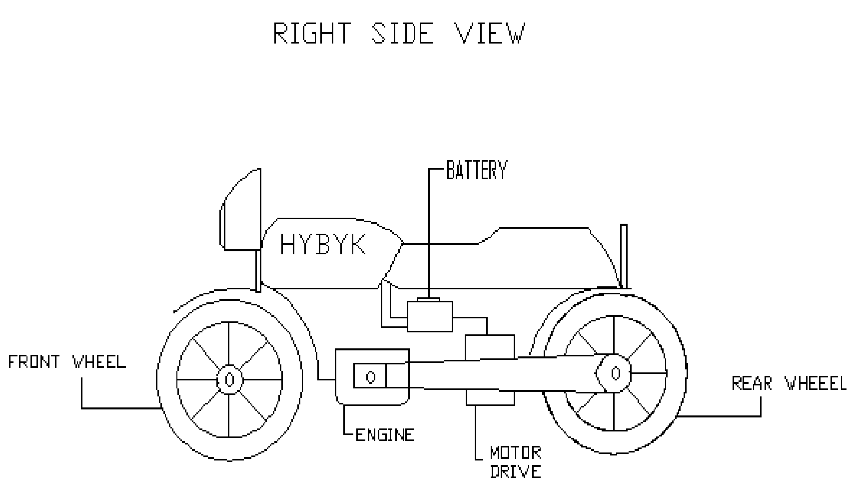

Fig 5.1: Showing the Right Side View of HYBYK, The Position and the Sprocket System of an Engine

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The output of engine is given to a gear box to achieve higher speeds and to reduce the fuel consumption. From gear box the power is transmitted to the rear wheel with the help of sprocket and chain drive assembly. A starter motor is provided for the aid of self starting characteristics.

5.2 Position of Electric Drive

The greatest challenge HYBYK faced was the position of electric drive in small space. Due to less space availability, congestion, weight of motor the choice of higher horse power motors was neglected.

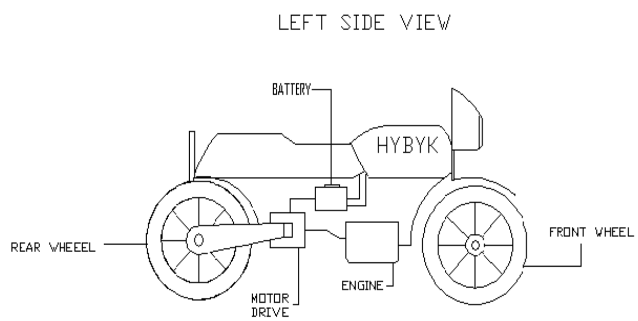

Fig. 5.2: Showing the Left Side View of HYBYK, The Position of Motor and the Sprocket Power Transmission System

From fig 4.2 it is clear that the electric drive is connected to the rear wheel with a separate sprocket system and it is placed on the other side of the sprocket of engine. The sprocket gearing option which is discussed in section 3.2.3 gives a clear idea for the increasing speed of electric drive.

The electric drive is placed in the space between the engine and the rear wheel. The drive is placed near the battery in order to reduce the transmission losses. The motor is rigidly fixed with the body of HYBYK. Clamping is done to fix the motor with the body.

5.3 Position of battery

Choosing the battery is another tedious job since the selection involves various factors to be considered. Factors such as compactness, power output, cost, reliability, self life has to be considered before selecting a battery. For keeping the battery in HYBYK a considerable space is required to satisfy this need the battery stack is placed underneath the seats. The seat act as a support, protective cover and also as a thermal resistance for the battery. The Plug-in outlet of the battery is kept out for Plug-in recharging of the vehicle.

5.4 Position of Dynamo

The dynamo is used for on-drive charging of the vehicle. Hence dynamo has to be connected to anyone of the wheel either front or rear. Dynamo does not require much space for it to be placed.

VI. THEORY OF POWER TRANSMISSION

The motor and engine are connected separately with the rear wheel of HYBYK. Hence power transmission involves two separate circuits connected to the rear wheel. The line diagram for such circuit is given as follows:

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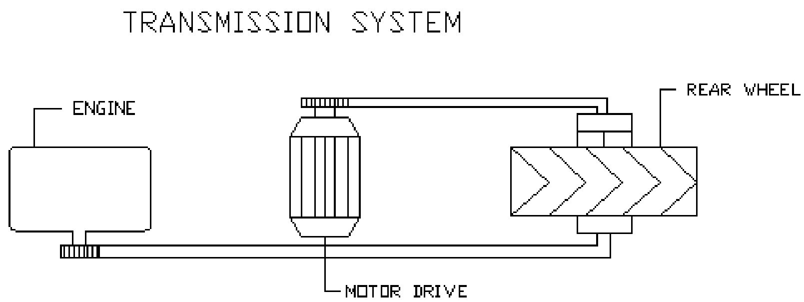

Fig. 6.1: Shows the Power Transmission Lines of HYBYK

The above diagram clearly depicts that there is no direct contact between the engine and the electric drive. Both the power transmitting lines comes to contact at the rear wheel shaft.

VII. Equations Concerned

7.1 Motor Equations

The expression for a motor action is as follows

F = BLI

Where,

F= Force in motor

B= Flux density

I= Current

L= Length of the windings

A motor can also act as a generator. The expression is as follows

E = BLV

Where,

E= Generator emf

Actual current flowing is given by

I = (V.E)/R

Where,

V= Applied voltage

E= Back emf

R= Resistance offered

Flux density is given by,

$B = \mu_0 \mu_r H$

Where,

μ_0= Magnetic constant or permeability of free space

μ_r= Relative permeability

7.1.1 Motor Torque Characteristics

Torque:

$T = K_1$ (IB)

Speed:

For DC,

$N = K_2$. (V/B)

For AC,

$N = K_3$. (F/P)

Where,

K_1, K_2, K3 are constants

F= Frequency

P= Number of poles

Power handling,

$P = \omega.T$

$P = (2\pi NT)/60$

Power Factor,

VAcosφ

Where,

V= Voltage

A= Current

φ= Phase angle

Case (i)

φ= 0

Current is in phase

Case (ii)

φ= 1

Current lags voltage by 90^0

Case (iii)

Cosφ = 0^0

No effective power is transmitted

Thus the system must have (1-cosφ) extra power to deliver nominal power

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7.2 Gearing Equations

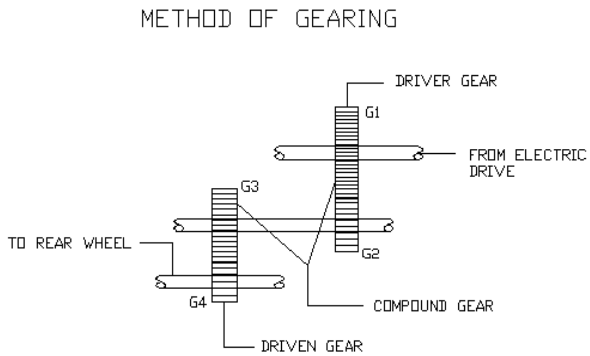

Fig. 7.1: Showing Sprocket Gear Drive of Motor

Drive of HYBYK

From Fig 6.1

N_1= Speed of driving $gear_1$

T_1= Number of teeth on driving $gear_1$

N_2, N_3, N_4= Speed of respective gears

T_2,T_3,T_4= Number of teeth in respective gears

Gears 1&2 are in mesh so that,

$(N_1/N_2)= (T_2/T_1)$ ____________ (1)

Similarly,

$(N_3/N_4)= (T_4/T_3)$ ___________ (2)

Multiplying (1) & (2) we get,

$(N_1/N_2)\times (N_3/N_4) = (T_2/T_1) \times (T_4/T_3)$

Since $N_2=N_3$

We have,

$(N_4/N_1)= (T_1/T_2) \times (T_3/T_4)$

$\mathbf{N_4= N_1\times [(T_1/T_2) \times (T_3/T_4)]}$

This expression shows that the output speed of gear assembly is greater than that of the input speed.

VIII. MODE OF USAGE

HYBYK offers two mode of usage for its user. The two modes are as follows:

1. High speed mode
2. Urban stop-and-go mode

8.1 High Speed Mode

High speed mode offers a wide range of advantage and hence it is used for longer distance travel in a much effective way. This mode uses petrol engine to run. At this mode battery will be in recharge mode. This mode can be used in traffic free areas.

8.2 Urban Stop-and-go Mode

This mode is applicable for traffic prone urban cities. This mode eliminates the power loss that is caused in the lower speeds of petrol engine. This mode saves fuel to a considerable rate. This is also a pollution free mode. It is used in short distant travel. This mode also offers a tension free smooth ride. It also lends the user a hand when petrol in tank gets empty.

With the great ease of efficiency and wide range of advantage, urban stop-and-go mode is a great boon for HYBYK.

IX. ENERGY EFFICIENCY

The comparison of energy for both petrol fuel and electricity is briefly discussed here.

9.1 Tank-to-wheel Energy Efficiency

9.1.1 High Speed Mode

The Ratio of energy that is transmitted to the wheels to the input to engine is discussed below.

The tank to wheel fuel efficiency for a best internal combustion is about **18%** tested under ideal conditions. This may vary widely depending on the driving style and in traffic. They are quite lower in congested urban traffic, since the engine operates at low or high speeds at which its efficiency is low.

To overcome this disadvantage an electric drive is used in urban traffic areas.

9.1.2 Urban stop-and-go mode

The tank to wheel efficiency for urban stop-and-go mode is about 60% to 75%. The electric drive has almost constant efficiency at almost every rotational speed. In urban stop-and-go mode only 40% to 25% is lost as heat during transmission.

The Tank-to-wheel efficiency of urban stop-and-go mode is about three times greater than High speed mode. Thus it is clear that urban stop-and-go mode can rightly be used in Traffic prone cities.

X. EMISSIONS

10.1 Tank-to-wheelCO_2 Emissions

10.1.1 High Speed Mode

Nominally for each kWh of energy that is transmitted to the wheels around 5.6 kWh of petrol is needed for Tank-to-wheel. This number might rise in real life traffic application.

Combustion energy of petrol is around **37MJ/l**

1kWh = 3.6 MJ

Combustion of 1 litre of petrol produces **2.35kgof CO_2**

Thus for each kWh of petrol that is converted into energy around **1490 kg of CO_2** is produced. Consider to how many digits this figure would raise on multiplying the total number of two wheelers present in our country.

10.1.2 Urban Stop-and-go Mode

The urban stop-and-go mode completely works with the help of a battery. The tank-to-wheel CO_2 emission of an electric drive is **Zero**.

The conventional electric vehicle has some well-to-wheel CO_2 emission. But to eliminate this emission too, HYBYK uses a special new concept called as **static solar power module which** converts solar power to generate electric currentsince solar energy is renewable and free from CO_2 emissions, it is a 100% cleaner, pollution free mode.

XI. PERFORMANCE CURVES

11.1 Engine Performance Curve

The engine characteristic curve is drawn between engine rpm and horsepower.

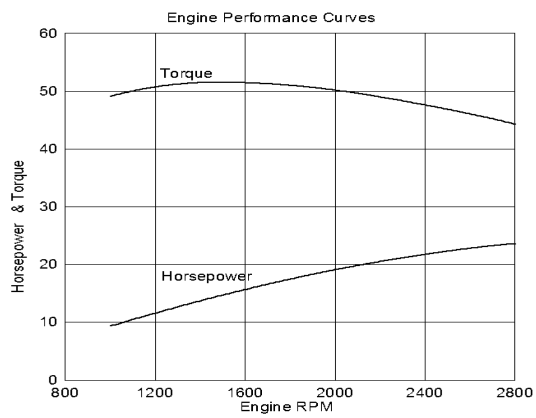

Fig 11.1: Showing the Performance of a 4 Stroke Single Cylinder Petrol Engine

Thus by drawing curves for various relationships in the governing equations of an engine the performance of a 4 stroke petrol engine can be analyzed.

11.2 Motor Performance Curve

The motor performance curves are analyzed between various properties such as current, speed and torque.

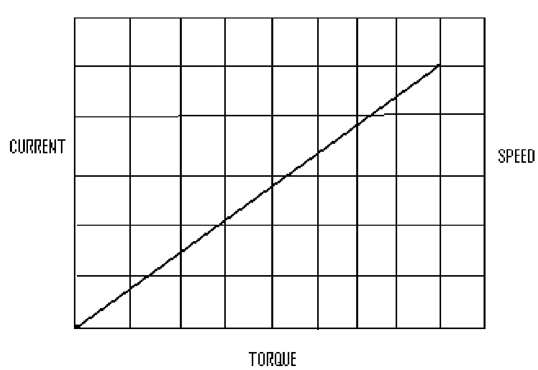

Fig. 11.2: Showing the Characteristic Curve between Torque, Speed and Current

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From the above graph it is clear that speed and current increases infinitely for a constantly increasing torque.

11.3 Battery Performance Curve

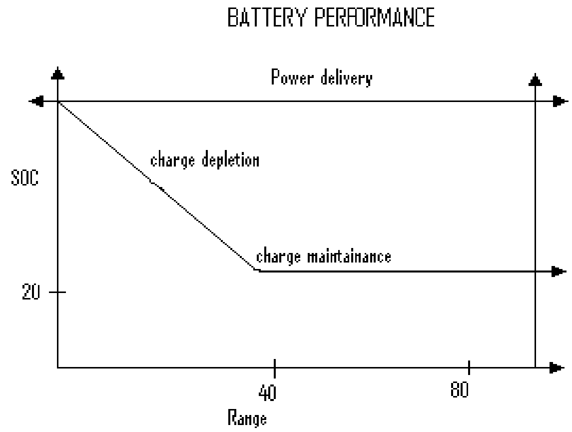

Fig. 11.3: Showing the Performance of a Battery

The battery performance curve shows the variation of power with the range of operation and state on charge.

Thus all the parameters that are to be briefly noted were discussed in the above few paragraphs.

XII. ADVANTAGES

The following are the advantages of using HYBYK

1. HYBYK gives a great ease of choosing the fuel that can be used for travel, hence it can reduce fuel consumption considerably.
2. It uses electric current as its fuel in urban traffic thus it reduces urban pollution.
3. Overall oil production can be reduced.
4. It can reduce urban traffic noise.
5. It has reduced fuel consumption cost.
6. By using Hybrid system, HYBYK has an increased performance.
7. The maintenance cost of HYBYK is very much less.
8. Since it can use a renewable form of energy to charge its battery, urban stop-and-go becomes almost pollution free.
9. It is a boon which serves as a medium between the advantages of petrol engine and as well as electric drives.
10. If properly merchandised HYBYK can be helpful in controlling the pollution, energy economy of a country.
11. If petrol gets empty there no need for the user to push the vehicle to fuel station instead the electric drive can a take to the fuel station.

XIII. DISADVANTAGES

Some of the disadvantage of using HYBYK is as follows

1. Upfront costs are higher than the comparable two wheelers at present.
2. Longer fill-up time of battery.
3. It is often difficult to take the battery to an apartment for recharging..

XIV. CONCLUSION

With the wide range of advantages HYBYK is an immediate solution which can be taken to meet the needs of a fuel efficient vehicle. We are in a present situation that it is highly impossible to eliminate fossil fuel completely. But it is the burden of every human being living on earth to provide a green globe to our future generations. HYBYK does not eliminate completely the usage of petrol in a two wheeler but it reduces the rate of fuel that is consumed. It is in the hands of every citizen to use pollution free vehicle but it becomes highly impossible to use such technologies. Due to this reason it is the duty of every citizen to switch on to at least fuel efficient, less polluting vehicle. Lets us join our hands to lend our future a pollution free green world.

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